

DECLARATION OF THE RECORD OF DECISION

SITE NAME AND LOCATION

Vancouver Water Station 1
Vancouver, Washington

STATEMENT OF PURPOSE

This decision document presents the selected final remedial action for Vancouver Water Station 1 (WS1) in Vancouver, Washington, which was developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the Administrative Record for the site.

The lead agency for this decision is the U.S. Environmental Protection Agency (EPA). The State of Washington Department of Ecology concurs with the selected remedy.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from WS1, if not addressed by implementing the response action selected in this Record of Decision (ROD), may present imminent and substantial danger to public health, welfare, or the environment.

DESCRIPTION OF THE SELECTED REMEDY

The City of Vancouver's public water supply wells at WS1 are contaminated with tetrachlorethene (PCE). No source for the PCE in the groundwater has been identified; therefore a remedy that is limited to treatment of the drinking water produced from WS1 has been determined to represent the maximum extent to which permanent solutions and treatment technologies can be used in a cost-effective manner. Even without a source control remedy, the concentration of PCE in groundwater at WS1 is expected to eventually decrease to a level below the maximum contaminant level (MCL).

The selected remedy for both cleanup of the public water supply and groundwater at WS1 is air stripping. Air stripping is a treatment technology in which the water to be treated trickles down through a tower in a packed column that breaks up the flow of water to create as much surface area as possible. Large volumes of air are then forced upward through the water, transferring the volatile contaminants from the surface of the water to the air through the process of evaporation. The air to which the contaminants have been transferred is then treated by forcing it through carbon filters, which adsorb the contaminants. The filters are then regenerated or treated and disposed of as a hazardous waste.

The air stripping system at WS1 has been in operation since 1993, before the site was listed on the National Priorities List. Use of air stripping has consistently reduced concentrations of PCE in treated water to below the level of detection. This action addresses the principal threat to human health—contamination of drinking water with PCE.

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All water pumped from WS1 is treated by air stripping and distributed to customers as drinking water. Groundwater is pumped from WS1 at a rate that varies between 8 and 19 million gallons per day, depending on the time of year and customer demand. While the primary purpose of air stripping is cleanup of the water being produced for distribution as drinking water, this action also serves as a pump-and-treat remedy that partially addresses the contamination of the groundwater at the site (source removal is not part of the selected remedy.)

STATUTORY DETERMINATION

The selected remedial action protects human health and the environment, complies with federal and state requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost-effective. This remedy utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable and satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element. Because this remedy will result in hazardous substances remaining on site above health-based levels, Water Station 1 will be subject to a 5-year review.



Chuck Clarke
Regional Administrator, Region 10
United States Environmental Protection Agency

9/11/98
Date

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ABBREVIATIONS AND ACRONYMS

ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COPC	contaminant of potential concern
DNAPL	dense nonaqueous-phase liquid
EPA	U.S. Environmental Protection Agency
FS	feasibility study
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
IRIS	Integrated Risk Information System
kg	kilogram
MCL	maximum contaminant level
μ g	microgram
mg	milligram
MSL	mean sea level
MTCA	Model Toxics Control Act
NCEA	National Center for Environmental Assessment
NCP	National Contingency Plan
NPL	National Priorities List
NTP	National Toxicology Program
PCE	tetrachloroethene (also known as perchloroethylene)
RAO	remedial action objective
RBSC	risk-based screening concentration
RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RI	remedial investigation
RME	reasonable maximum exposure
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SF	slope factor
TCA	1,1,1-trichloroethane
TCE	trichloroethene
UCL95	95 percent upper confidence limit

ABBREVIATIONS AND ACRONYMS (Continued)

VOC	volatile organic compound
WDOH	Washington State Department of Health
WS1	Vancouver Water Station 1
WS3	Vancouver Water Station 3
WS4	Vancouver Water Station 4

DECISION SUMMARY

1.0 INTRODUCTION

In accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), the U.S. Environmental Protection Agency (EPA) is selecting under CERCLA the existing air stripping treatment system to address environmental contamination at Vancouver Water Station 1 (WS1) in the city of Vancouver, Washington. The selected treatment system has been constructed and is operational.

The selected action has the concurrence of the Washington State Department of Ecology (Ecology) and is responsive to the expressed concerns of the public. The selected action complies with applicable or relevant and appropriate requirements (ARARs) promulgated by Ecology, EPA, and other state agencies.

2.0 SITE NAME, LOCATION, AND DESCRIPTION

WS1 lies within Waterworks Park in the city of Vancouver, Washington. Vancouver is located in Clark County in the southwestern corner of Washington state, across the Columbia River from the city of Portland, Oregon.

WS1 is near the center of the city, approximately 0.75 miles east of Interstate 5 and approximately 2 miles north of the Columbia River (Figure 2-1). The site is located on the southeast corner of Fourth Plain Boulevard and Fort Vancouver Way, and is bounded on the west by Clark College, and to the east by East X and Y Streets, and to the south by East 21st Street. It lies adjacent to a commercial district and residential areas.

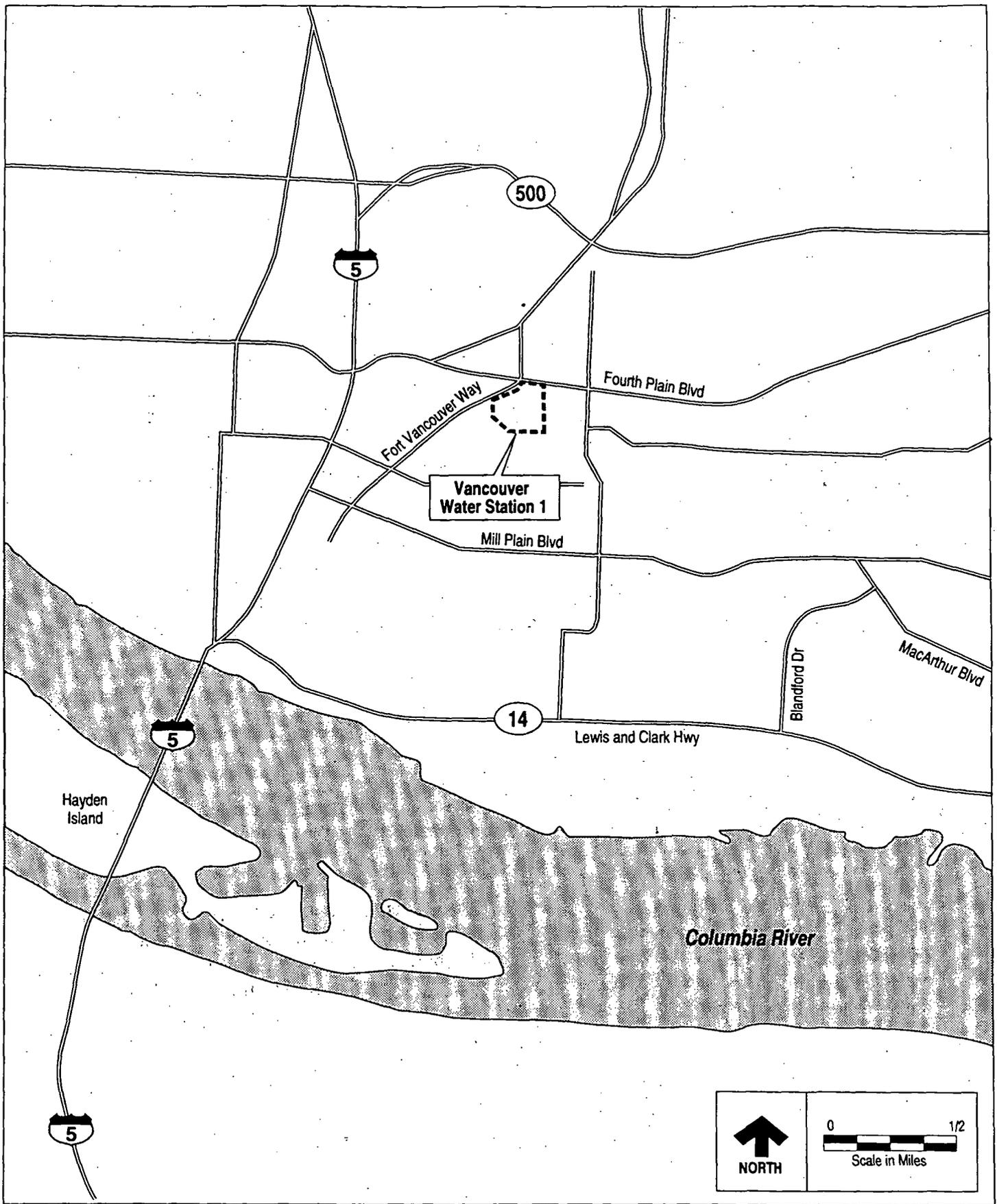


Figure 2-1
Site Location Map
Vancouver Water Station 1

EPA Region 10
 Vancouver Water Station 1
 ROD

WS1 has 10 groundwater production wells and a holding reservoir used to provide storage capacity to accommodate daily fluctuations in water demand (Figure 2-2). WS1 supplies drinking water to approximately 150,000 residents, or about one-half of the drinking water for Vancouver. The balance of drinking water is supplied by other similar wellfields in and around the city.

The aquifer from which WS1 draws its water is known as the Troutdale Formation. The Troutdale Formation, the upper portion of which is approximately 200 feet below ground surface, supplies water to several municipal wellfields and an unknown number of private wells. All known private wells are used for irrigation or filling swimming pools. None of the private wells are known to be used for drinking water.

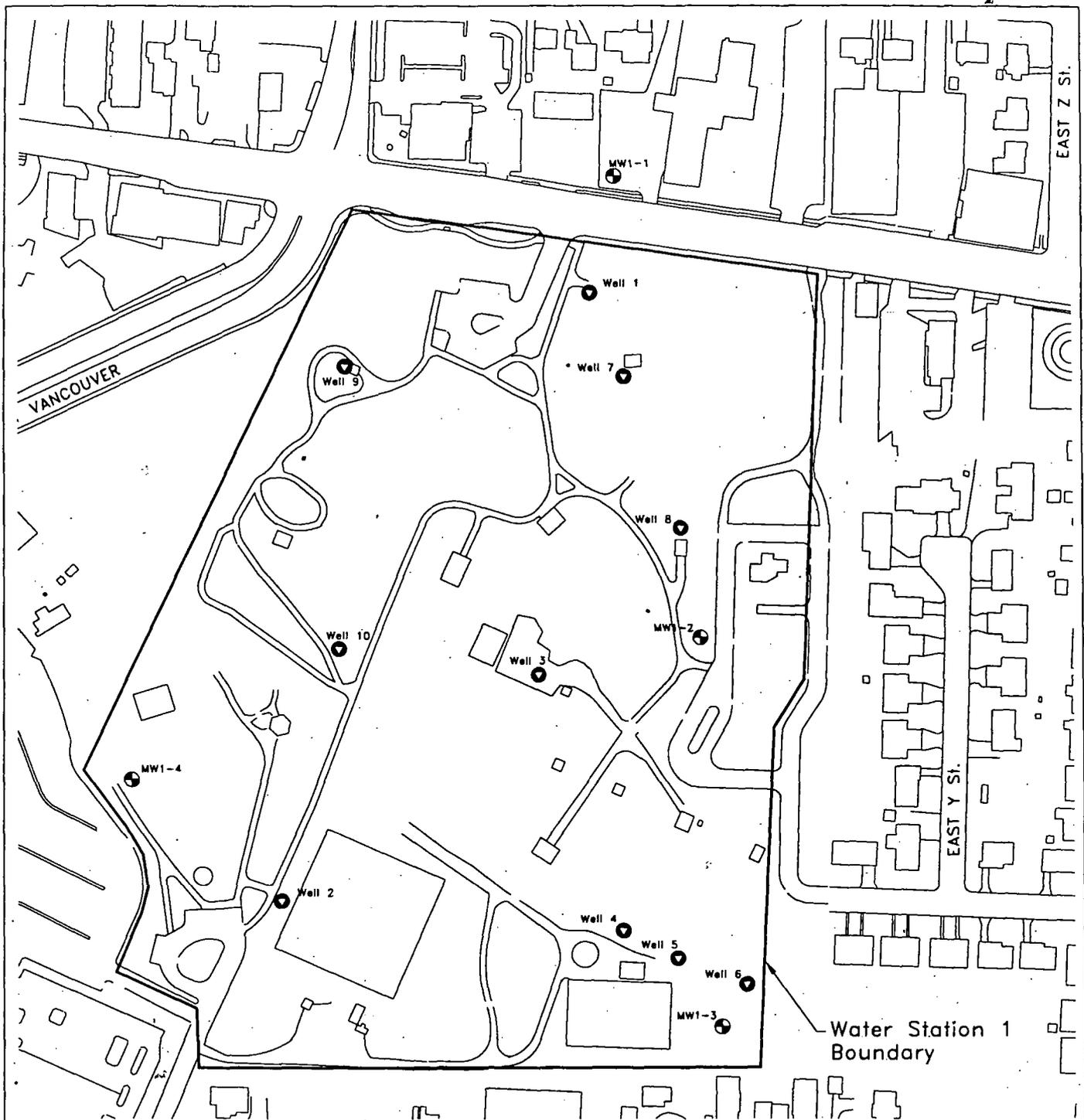
There are no wetlands, floodplains, threatened or endangered species, or properties on or eligible for the National Registry of Historic Places on this site.

3.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

The wellfield at WS1 has been owned by the City of Vancouver for over 60 years. The reservoir was constructed in 1936 and Production Well 1 was installed in 1937. Additional wells were installed at the rate of approximately one per decade, with the most recent wells coming on line in 1982. Water from WS1 is blended together with water from several other wellfields to provide drinking water to the Vancouver region. The combined water supply system provides drinking water to approximately 150,000 people throughout the Vancouver area. Approximately one-half of the total water system production is supplied by WS1.

When the federal Safe Drinking Water Act (SDWA) was amended to require suppliers of public drinking water to monitor for volatile organic compounds (VOCs), the City of Vancouver began monitoring water from WS1 and its other wellfields. Results of this monitoring, which began in March 1988, indicated a persistent presence of tetrachloroethene (also known as perchloroethylene, or PCE) in the water at WS1. In February 1989, in consultation with the Washington State Department of Health (WDOH), the City notified the public of the presence of PCE in the groundwater at both Water Station 4 (WS4) and WS1. Because PCE concentrations at WS1 were much lower than those at WS4, the notice stated that WS1 water was being blended with WS4 water to reduce overall PCE concentrations.

In May of 1989, EPA proposed a maximum contaminant level (MCL) for PCE for public drinking water systems of 5.0 micrograms per liter ($\mu\text{g/L}$). Samples collected from the production wells in



Legend

== Roads, Sidewalks, Driveways, Parking

Well 1 ● City Production Well

MW1-3 ● Monitoring Well

Notes: MW1-2 was abandoned in 1997.
 MW1-5 (located at East 13th and East Z Streets) is approximately one-third mile south of MW1-3.



0 50 100 200
 SCALE IN FEET

Figure 2-2
City of Vancouver
Production Well and
Monitoring Well Locations

EPA Region 10
 Vancouver Water Station 1
 ROD

July 1989 showed concentrations of PCE ranging from 0.3 to 3.7 $\mu\text{g/L}$, with an average concentration of 0.95 $\mu\text{g/L}$.

In July 1989, the City of Vancouver initiated field investigations to determine if there was a source or sources of PCE or other VOCs near WS1. A soil-gas survey was conducted in the WS1 area, and 19 soil-gas samples were collected and analyzed. In addition, groundwater samples were collected from five existing private wells located within a 1-mile radius of WS1. There was no pattern in the soil or groundwater results that indicated a source of PCE.

In August 1989, EPA Region 10 began a study that included soil-gas surveys and groundwater monitoring, in another attempt to identify potential sources of the PCE detected at WS1 and several other Vancouver water stations. Eight groundwater samples were collected from production wells at WS1 and Water Station 3 (WS3) (located approximately 1 mile northwest of WS1) and from private wells within approximately a 1-mile radius of WS1. A total of 194 soil-gas samples were collected throughout the city of Vancouver during the Phase I study, with 20 of the samples collected in the vicinity of WS1.

Phase II of this study focused on potential PCE sources within the vicinity of WS1 by collecting more than 100 additional soil-gas samples from 40 locations north and east of the site in February and March of 1990. To provide soil-gas depth profiles, multiple soil-gas samples were collected from each sampling location and analyzed in the field for VOCs.

The results of both phases of the investigation failed to identify a potential source of the PCE entering WS1. PCE was detected in soil gas samples collected just north of the WS1, although the concentrations were not high enough to indicate that the area was responsible for the contaminated groundwater at WS1. Groundwater monitoring wells in and adjacent to the wellfield have never shown concentrations of PCE above the MCL. Because significant concentrations of PCE have not been detected except in the production wells, it is not possible to identify where the PCE originated (a source) or how it got to the well field (a plume).

EPA issued its final MCL for PCE (5.0 $\mu\text{g/L}$) in January 1991, with an effective date of July 1992 (40 CFR Part 141).

In 1991 the City expanded the monitoring at WS1 to include weekly PCE analyses for each of the 10 production wells. Because demand for water rarely required the output from all 10 wells, the City was able to use results of the monitoring to determine which wells to use for production to minimize the concentration of PCE in the water delivered to its customers. Water was drawn first from wells with the lowest concentration of PCE. Wells with higher levels of PCE were used only as necessary to meet peak demand. All of the water was mixed and stored in the reservoir

prior to delivery to customers. Although the concentration of PCE in a few wells at WS1 was greater than the MCL, the combined output from WS1 (measured at the reservoir) was always less than the MCL.

In the fall of 1992, EPA conducted a hydrogeologic assessment of the Vancouver area, and installed five groundwater monitoring wells in the vicinity of WS1 (see Figure 2-2). Depth-specific groundwater samples were collected during drilling of these wells; PCE was detected in groundwater samples from only one well (MW1-3) at depths between 260 and 280 feet below ground surface (bgs). Lithologic soil sampling was conducted during construction of one of the wells (MW1-1); PCE was detected in soil samples at depths of between 30 to 60 feet bgs, and again at approximately 80 feet bgs. Following well development, groundwater samples were collected from all five of the monitoring wells, but PCE was detected in only one of the five wells (MW1-3).

From 1991 through 1992, monitoring of the 10 production wells showed a trend of continuing, and possibly increasing, concentrations of PCE in the groundwater at WS1. Although the PCE concentration in the combined output at WS1, measured at the reservoir, remained below the MCL, the concentrations in a few wells were consistently above the MCL. To ensure that city drinking water was protected, in May 1993 the City of Vancouver installed five air stripping towers at WS1 to remove PCE from the drinking water produced by the wells. These towers are still operating. Groundwater produced from the 10 wells is pumped to the towers for treatment, and the treated water is then transferred to the reservoir before distribution to water customers. The air strippers have reduced PCE concentrations in public drinking water to nondetectable levels. Following installation of the air stripping treatment system, the City changed the frequency of its monitoring of the untreated water from weekly to monthly.

Although the air stripping system was effectively removing PCE from water that the City was distributing for drinking water, Vancouver WS1 was proposed for the National Priorities List (NPL) in June 1993 because of the presence of PCE in the groundwater. The maximum detected PCE concentration ($30.0 \mu\text{g/L}$) was reported from Production Well 1 on June 28, 1993.

In 1993 EPA conducted a study to evaluate the WS1 site for potential removal actions to mitigate threats to public health. The study found that no immediate threats to public health existed from WS1 because appropriate action (air stripping) had already been implemented. However, concentrations of PCE in groundwater continued to exceed the MCL, so in June of 1994 the site was officially placed on the NPL.

As required under CERCLA, a preliminary health assessment was conducted by WDOH under cooperative agreement with the U.S. Department of Health and Human Services' Agency for

Toxic Substances and Disease Registry. Released for public comment in fall 1994, the preliminary health assessment concluded that there was no apparent health hazard from exposure to PCE in drinking water supplied by WS1, although WDOH did recommend further investigation of PCE contamination in the groundwater near WS1.

At about that time, funding constraints led to a decision by EPA to postpone further investigations of WS1, saving EPA's limited funding for sites with greater risk.

In July 1997 EPA conducted groundwater sampling at all five of its monitoring wells at WS1 because monitoring well MW1-2 was scheduled for abandonment to facilitate construction of a skateboard park by the City. Samples were collected using low-flow techniques and were analyzed for VOCs. PCE was detected only at MW1-3 and MW1-5, with only the sample from MW1-5 exceeding the MCL of 5.0 $\mu\text{g/L}$.

In November 1997 EPA initiated a remedial investigation/feasibility study (RI/FS) and risk assessment for WS1. EPA sampled all existing monitoring wells in March 1998. PCE was detected only at MW1-3 and MW1-5, but neither sample exceeded the MCL. In July 1998 EPA released the final RI/FS report for WS1. The results of the RI/FS report are summarized in this ROD.

4.0 COMMUNITY RELATIONS

4.1 CITY OF VANCOUVER COMMUNITY RELATIONS EFFORTS

Most of the City's public information efforts regarding water quality at water production facilities have focused on Water Station 4 (WS4). In February 1989 the City of Vancouver notified users of public water that PCE had been detected in wells at WS4. However, because PCE concentrations at WS1 were much lower than concentrations at WS4, the notice stated that the City was reducing the amount of water pumped from WS4 and increasing the amount of water pumped from WS1 to minimize the overall PCE concentrations. (In October 1989, the City took WS4 out of service until a treatment system could be installed.)

Primarily in response to the water quality concerns at WS4, in 1989 the City began providing its water customers with an annual water quality report that it included with each customer's March billing statement. The contamination at WS4 was the subject of the first report.

Also in response to the water quality concerns at WS4, in 1989 the City sponsored formation of the Water Quality Advisory Committee, which includes medical and legal experts, members of the community, state regulators, and representatives from the City's water department. The Advisory Committee serves as a forum where the City disseminates technical information to the public and receives input regarding the community's concerns. The Advisory Committee issues recommendations to the City's Public Works Director and was instrumental in designing the City's policy for notifying the public about water quality incidents.

4.2 EPA COMMUNITY RELATIONS EFFORTS

No formal Community Relations Plan has been developed for WS1. Most of EPA's public information efforts have focused on WS4, with information regarding WS1 sometimes included in Fact Sheets for WS4 distributed by EPA.

EPA issued a Fact Sheet in July 1992 entitled "Vancouver Water Station #4 Contamination Superfund Site." This Fact Sheet contained a paragraph noting that EPA also planned to install monitoring wells near WS1, and that the City was installing a treatment system at WS1 scheduled to begin operation in 1993.

EPA issued a Fact Sheet dated February 1, 1993, that was devoted to the Community Relations Plan for WS4 and did not mention WS1. The Fact Sheet included a summary of concerns voiced during EPA interviews with members of the community conducted on September 21 and 22, 1992. The comments summarized were either about WS4 or about general area-wide water quality; none mentioned WS1 specifically.

The September 6, 1994, Fact Sheet was entitled "Vancouver Water Stations #1 and #4 Contamination Sites." The discussion of WS1 noted that the air stripping system was removing the contamination from the water at WS1 to below federal drinking water standards, and announced that the site had been added to the NPL as of June 1994.

The most recent Fact Sheet was released June 18, 1998, and provided summaries of previous activities at both WS1 and WS4. The Fact Sheet noted that the Proposed Plan for WS1 was expected to be issued in July 1998, with the Proposed Plan for WS4 following in early 1999.

The RI/FS report and Proposed Plan for WS1 were released to the public in July 1998. These two documents were made available to the public in the Administrative Record maintained at U.S. EPA Region 10, 1200 Sixth Avenue, Seattle, Washington, and at the information repository maintained at the Vancouver Public Library, Fort Vancouver Branch, 1007 E. Mill Plain

Boulevard, Vancouver, Washington. The notice of availability of these two documents was published in the *Vancouver Columbian* on July 22, 1998.

A public meeting for the proposed plan was not scheduled. A public comment period was held from July 22, 1998, to August 21, 1998. Two comments on the Proposed Plan were received from the public. The community had an opportunity to request a public meeting during the public comment period on the Proposed Plan, but no requests for a public meeting were received.

This decision document presents the selected remedial action for the WS1 site in Vancouver, Washington, chosen in accordance with CERCLA, as amended by SARA, and, to the extent practicable, the NCP. The decision for this site is based on the Administrative Record.

5.0 SCOPE AND ROLE OF RESPONSE ACTION

This site consists of one operable unit. The selected remedy is the final action at this site.

Several investigations spanning several years were previously conducted to identify the source of PCE entering WS1, but neither a source nor a plume of PCE was ever identified. No additional investigation into potential sources was conducted during the RI/FS because there were no areas with sufficient potential as a source. No additional wells were installed to attempt to identify a plume because (1) the concentrations of PCE in the wellfield were relatively low, (2) with no suspected source areas to investigate, the locations of new wells would in effect be random, and (3) there was a low probability that additional information would lead to a change in the operating treatment system.

Because neither a source nor a plume of PCE entering the wellfield at WS1 has been identified, the scope of the response action at WS1 is limited to the following:

- Ensuring that human health is protected by reducing the level of PCE in drinking water produced from WS1 to meet federal drinking water standards
- Reducing the concentration of PCE in the groundwater at WS1 to below the MCL of 5 $\mu\text{g/L}$

Without a known or suspected source, no action can be taken to clean up the source of the PCE entering the wellfield. Without an identified plume of PCE, no action can be taken to treat contaminated groundwater moving into the wellfield from off site. The response action is

therefore limited to the groundwater at the wellfield and to drinking water produced by WS1 for distribution to the public.

EPA's response action for WS1 is to select the continued treatment of drinking water produced from WS1 by using the air stripping treatment system that is already in operation. Continued operation of WS1 to provide drinking water will also serve as a treatment system for the contaminated groundwater at the wellfield.

6.0 SUMMARY OF SITE CHARACTERISTICS

6.1 PHYSICAL CHARACTERISTICS

6.1.1 Surface Features

The Vancouver area is situated on a series of gentle terraces rising to the north from the Columbia River. WS1 is located near the edge of one of these terraces. Topography is flat in the northern two-thirds of the site with a ridge running west-northwest to east-southeast in the southern third. Vertical relief of this ridge is approximately 50 to 70 feet. Topography slopes gently to the south from this ridge to the next terrace level.

Water Station 1 is located within the Waterworks City Park, which is landscaped with grass and mature coniferous trees, as is the campus of Clark College, located approximately 1,500 feet to the southwest. However, the vicinity also includes residential, light manufacturing, and commercial businesses, resulting in large portions of paved or built-over areas. Paved areas are typically equipped with stormwater drains, which are part of the city's stormwater system.

The site is located about 2 miles north of the Columbia River, on a terrace at an elevation of approximately 160 to 230 feet above mean sea level (MSL). The site is generally flat in the northern portion. A ridge trends northwest to southeast along the southern portion of the site with a maximum south-to-north relief of approximately 70 feet. Most of the area is well drained due to the underlying coarse alluvial deposits.

6.1.2 Geology

The geological setting of the Vancouver area consists of 2,000-foot thick Cenozoic-Age basaltic basement rock overlain by Miocene to Pliocene Age sedimentary bedrock units (the Lower and

Upper Members of the Troutdale Formation), topped with Pleistocene to Holocene Age unconsolidated alluvial sediments.

The sediments of the Upper Member of the Troutdale Formation contain a lower layer of coarse-grained sandy gravel and an upper layer of cemented gravel. A period of erosion and weathering followed deposition of the Troutdale Formation, resulting in a highly weathered zone at the top of the Troutdale Formation and a thin soil horizon. The Pleistocene alluvium of the Orchards Gravel overlies the Troutdale Formation. The Orchards Gravel is composed of coarse-grained sand and gravel in the area of the Columbia River floodplain with finer-grained sands present as lenses and/or stringers within the coarse-grained material in the terraced areas. The Orchards Gravel contains variable amounts of silt in the area of WS1. The Orchards Gravel ranges from 75 feet thick in the Columbia River floodplain to 120 feet thick at the top of the terrace.

The varying amounts of silt within the sand matrix at WS1 could result in decreased vertical and horizontal permeability in local areas, which could also locally decrease "percolation" or vertical migration rates of a contaminant. The boring log for MW1-1 identifies a silt layer with some sand and trace clay from 80 to 82 feet bgs (99 to 97 feet above MSL). The boring log from MW1-2 identifies a silt with some sand from 66 to 70 feet bgs (110 to 106 feet above MSL). The boring log from MW1-3 identifies silt with some clay interbedded with sand from 54 to 62 feet bgs (178 to 170 feet above MSL). The boring logs for MW1-4 and MW1-5 do not identify fine-grained sediments in the explored column.

The occurrence of thin, fine-grained material at the WS1 site appears to either be laterally discontinuous, or if continuous, sloping to the north. Regardless of the lateral continuity, it is possible that localized pockets of pure PCE, referred to as dense nonaqueous phase liquid (DNAPL), could exist in the fine-grained sediments. PCE concentrations in samples of these sediments collected during the installation of MW1-1 were not high enough to suggest the presence of DNAPL. (If DNAPL were present in the sediments, the concentrations of PCE would probably be in the parts-per-million range, not in the parts-per-billion [$\mu\text{g/L}$] range detected at MW1-1.) It is, however, possible that DNAPL is present in an unexplored portion of the site or within the capture zone of WS1.

6.1.3 Hydrogeology

Groundwater in the Vancouver area is produced primarily from two formations, the Orchards Gravel and the lower portion of the Upper Member of the Troutdale Formation. WS1 produces groundwater from a gravel unit within the lower portion of the Upper Member of the Troutdale Formation, which extends approximately 200 to 250 feet below ground surface.

The hydraulic gradient is reported to be south-southwest toward the Columbia River in the Orchards Gravel and Troutdale Formation. Specific capacities are reported to exceed 300 gallons per minute per foot of drawdown, and the individual production well yields range from 1,000 to 3,400 gallons per minute.

Groundwater was reported at depths ranging from 175 to 228 feet below ground surface. The apparent groundwater flow direction under static conditions is expected to be to the south or southwest, but operation of the production wells at WS1 influences local groundwater flow direction to the wellfield area. The estimated 30-year zone of capture for WS1 is approximately 10 square miles.

6.2 NATURE AND EXTENT OF CONTAMINATION

PCE is the primary chemical of concern, although trichloroethene (TCE), 1,1,1-trichloroethane (TCA), and toluene have also been detected. Summaries of concentrations by medium are presented in the following sections.

6.2.1 Soil-Gas

Soil-gas surveys were performed by both the City and EPA in an attempt to identify a source for the PCE in groundwater. The data generally agree as to the distribution of PCE in soil-gas in the WS1 area, with the highest concentrations in samples collected from near-surface soil (5 to 23 feet below ground surface) approximately 80 to 120 feet northwest of Production Well 1 (across Fourth Plain Boulevard from WS1). However, as discussed in Section 6.2.2, the detected PCE soil-gas concentrations do not appear to be high enough to support the identification of a contaminant source.

City of Vancouver Soil-Gas Survey Results

PCE was detected in 15 of the 19 soil-gas samples collected by the City, with concentrations ranging from 0.003 $\mu\text{g/L-air}$ to greater than 0.450 $\mu\text{g/L-air}$. Four of the 19 soil-gas samples were analyzed for TCE, with concentrations ranging from 0.013 to 0.060 $\mu\text{g/L-air}$.

EPA Phase I Soil-Gas Survey Results

PCE, TCE, and TCA were detected during EPA's Phase I soil-gas survey. PCE was detected in 18 of 20 samples at concentrations ranging from 0.016 $\mu\text{g/L-air}$ to 11 $\mu\text{g/L-air}$. TCE was detected in 4 of 20 samples at concentrations ranging from 0.015 $\mu\text{g/L-air}$ to 0.11 $\mu\text{g/L-air}$. TCA

was detected in 7 of 20 samples at concentrations ranging from 0.018 $\mu\text{g/L}$ -air to 2.5 $\mu\text{g/L}$ -air. Toluene was detected in 19 of 20 samples, reported as an average concentration of 0.07 $\mu\text{g/L}$ -air.

EPA Phase II Soil-Gas Survey Results

PCE, TCE, TCA, and toluene were detected during EPA's Phase II soil-gas survey. PCE was detected in 21 of 104 samples with an average reported concentration of 0.90 $\mu\text{g/L}$ -air and a maximum concentration of 8 $\mu\text{g/L}$ -air. TCE was detected in 2 of 104 samples with an average reported concentration of 0.033 $\mu\text{g/L}$ -air. TCA was detected in 8 of 104 samples with an average reported concentration of 0.142 $\mu\text{g/L}$ -air. Toluene was reported in 27 of 104 samples with an average reported concentration of 0.026 $\mu\text{g/L}$ -air.

EPA soil gas survey results indicated that the highest TCE concentrations were located approximately 115 feet north-northwest of the intersection of Fourth Plain Boulevard and the Waterworks Park entrance. The highest TCA concentrations were located approximately 100 feet north-northwest of this same intersection. Sample depths ranged from 5 to 23 feet below ground surface.

6.2.2 Soil

Neither the measured nor the estimated concentrations of PCE in soil were indicative of a significant source area as discussed in the following subsections.

Direct Measurements of PCE in Soil

Soil samples were collected during the installation of MW1-1 in the fall of 1992. Soil samples collected from the MW1-1 boring were analyzed in the field using gas chromatography. PCE was detected in soil samples collected from the MW1-1 boring at depths of 30 to 60 feet below ground surface (bgs) and at approximately 80 feet bgs, with concentrations ranging from 0.0006 to 0.034 milligrams per kilogram (mg/kg). The highest PCE detection in soil (0.034 mg/kg) was at a depth of 55 to 56.5 feet bgs. The soil samples collected from 60 to 61.5 feet bgs were described in the boring log as wet, suggesting possible localized perched water conditions. Toluene was detected at depths ranging from 20 to 116.5 feet bgs. However, toluene was detected only in the field soil sample collected during well installation and was not detected in the groundwater sample collected following well installation and development.

Estimated Concentrations of PCE in Soil

As noted in the preceding paragraph, the only data available on concentrations of PCE in soil in the WS1 area come from one location, MW1-1. However, much more extensive information was available in the form of soil-gas data. In an attempt to determine the location of a potential PCE source area(s), an estimate of the maximum PCE concentration in soil was calculated from soil-gas data. Estimated concentrations of PCE in the soil were extrapolated using a series of assumptions regarding the characteristics of soil in the area and the highest documented soil-gas PCE concentration of 11 $\mu\text{g/L}$ -air (measured by field analysis) as a conservative assumption. The estimated concentration of PCE adsorbed to soil ranged from approximately 0.0062 mg/kg to 0.014 mg/kg. The estimated leachate concentration was thus approximately 3 $\mu\text{g/L}$. Dilution and attenuation of this leachate during migration through approximately 175 feet of unsaturated soil, mixing in groundwater, and groundwater transport to the wellfield, would result in much lower concentrations of PCE than those measured at the wellfield. Because site-specific attenuation data were not available for this area, the standard attenuation factor used by EPA for small sites is applicable; this factor is 20. Using this standard (and most likely conservative) attenuation factor would result in groundwater concentrations of PCE at the WS1 of approximately 0.2 $\mu\text{g/L}$.

6.2.3 Groundwater

PCE is the only VOC that has been detected in groundwater at concentrations greater than its MCL at any production, monitoring, or private well in the vicinity of WS1. Analytical results from production well monitoring and groundwater monitoring show that PCE concentrations appear to have decreased from a peak in the early 1990s. It should be noted, however, that PCE is the only chemical that the City of Vancouver monitors for individual production wells at WS1. Production well sampling results were the only data available to EPA on the condition of the groundwater at WS1. A full range of chemicals is analyzed for in samples collected from the reservoir, but all samples collected from the reservoir since the air strippers were installed have shown nondetectable levels of VOCs (as would be expected).

Screen intervals for production wells at WS1 range from 13 to 83 feet below mean sea level (MSL) and screen intervals for monitoring wells MW1-1 through MW1-4 range from 5.5 to 59 feet below MSL.

Results of the various sampling programs are discussed in the following subsections.

Sampling of Production Wells

PCE has been detected in all 10 production wells. During the 6-year period summarized in Table 6-1, average concentrations of PCE ranged from 1.1 $\mu\text{g/L}$ in Production Well 10 to 5.0 $\mu\text{g/L}$ in Production Well 5 and 5.3 $\mu\text{g/L}$ in Production Well 1. PCE concentrations in water samples from the production wells appear to have decreased. The maximum detected PCE concentration (30.0 $\mu\text{g/L}$) was reported for a sample collected from Production Well 1, located near the northern site boundary (Figure 2-2) on June 28, 1993.

Table 6-1
Summary of PCE Concentrations in Production Wells at WS1
(6-19-91 Through 6-1-98)

Well ID	Max. PCE ($\mu\text{g/L}$)	Max. Date(s)	Min. PCE* ($\mu\text{g/L}$)	Most Recent Min. Date	Number of Samples	Average PCE ($\mu\text{g/L}$)	Standard Deviation	Coefficient of Variation
1	30.0	06/28/93	0.2	10/14/91	147	5.3	3.7	0.70
2	5.7	12/30/91, 03/04/96	0.4	04/26/93	129	2.1	1.0	0.37
3	15.0	03/09/92, 04/13/92	0.4	10/06/97	144	4.8	3.0	0.63
4	12.0	04/13/92	0.4	10/06/97	145	4.5	2.4	0.53
5	18.0	04/13/92	0.4	12/02/96	149	5.0	2.8	0.56
6	9.6	03/06/95	0.4	01/06/97	149	2.6	1.8	0.69
7	9.3	04/06/98	0.4	10/03/94	150	2.3	1.2	0.52
8	5.9	03/06/95	0.2	11/30/92	138	2.1	1.2	0.57
9	5.8	08/02/93	0.0	09/14/92	145	1.5	1.1	0.73
10	5.4	04/06/98	0.0	09/14/92	150	1.1	0.7	0.64
					1,446	3.2	2.7	0.84

*Values may be laboratory detection limits, indicating that PCE was not actually detected above these (presumed) limits.

Notes:

Wells 1 through 10 (entire population)

Concentrations in micrograms per liter ($\mu\text{g/L}$) or parts per billion (ppb) equivalent

PCE - tetrachloroethene

Sampling of Private Wells

Groundwater samples were collected from five private wells by the City of Vancouver. Two of the five wells contained detectable concentrations of PCE, at concentrations of 0.9 $\mu\text{g/L}$ and 1.4 $\mu\text{g/L}$, well below the MCL.

Sampling of Monitoring Wells During Installation

During installation of the five monitoring wells in the fall of 1992, groundwater samples were collected and analyzed in the field. PCE was detected in the groundwater samples from only one of the five monitoring wells, MW1-3, at depths of 260 feet bgs (3.0 $\mu\text{g/L}$) and 280 feet bgs (0.9 $\mu\text{g/L}$). Field analysis did not detect TCE, 1,1-dichloroethene, trans-1,2-dichloroethene, benzene, chlorobenzene, or ethylbenzene at concentrations above detection limits at any of the five monitoring wells. However, the field analysis did detect toluene (14.4 $\mu\text{g/L}$) in one sample collected from MW1-1 at a depth of 206.5 feet bgs.

Sampling of Monitoring Wells Following Installation

In addition to the field-analyzed samples collected during well installation, groundwater samples have been collected from MW1-1 through MW1-5 on three different occasions: October 1992, July 1997, and February 1998. As shown in Table 6-2, although PCE has been detected in all 10 of the production wells at WS1, it was detected in only 2 of the 5 monitoring wells (MW1-3 and MW1-5), and only MW1-5 had PCE concentrations that exceeded the MCL (6.6 and 6.8 $\mu\text{g/L}$). MW1-5 is approximately one-third mile south of WS1 and is probably near the edge of the zone of influence for WS1. TCE was reported at an estimated concentration below the detection limit. Trichlorofluoromethane was the only other VOC positively detected in samples collected from the monitoring wells, and it is probably a laboratory contaminant.

Table 6-2
Analytical Results for PCE and TCE in Groundwater Samples
From MW1-1 Through MW1-5

Well ID	Sampling Date	PCE ($\mu\text{g/L}$)	TCE ($\mu\text{g/L}$)	Screen Interval
MW1-1	10/92	0.9M	NA	-5.50 to -25.50 ft MSL
	7/97	1U	1U	185.0 to 205.0 ft bgs
	3/98	1U	1U	
MW1-2	10/92	0.5M	NA	-38.70 to -58.70 ft MSL
	7/97	1U	1U	215.0 to 235.0 ft bgs
	3/98	W/A	W/A	W/A
MW1-3	10/92	4.7	NA	-27.60 to -47.60 ft MSL
	7/97	1.6	1U	260.0 to 280.0 ft bgs
	3/98	1.5	1U	
MW1-4	10/92	1U	NA	-28.20 to -48.20 ft MSL
	7/97	1U	1U	250.0 to 270.0 ft bgs
	3/98	1U	1U	
MW1-5	10/92	6.8	NA	-36.10 to -56.10 ft MSL
	7/97	6.6	0.12J	195.0 to 215.0 ft bgs
	3/98	3.5	1U	

Notes:

ft bgs - feet below ground surface
 ft MSL - feet above mean sea level
 J - estimated value
 M - below detection limit
 $\mu\text{g/L}$ - micrograms per liter or part per billion (ppb) equivalent

NA - not analyzed or not reported
 PCE - tetrachloroethene
 TCE - trichloroethene
 U - not detected above specified detection limit
 W/A - well abandoned

7.0 SUMMARY OF SITE RISKS

Typically, a baseline risk assessment is conducted during the remedial investigation at an NPL site. A baseline risk assessment is an analysis of the potential adverse health effects caused by hazardous substance release from a site in the absence of any actions to control or mitigate these releases. WS1 differs from the typical NPL site in that remedial action (air stripping treatment of drinking water produced from WS1) has already been implemented. Because of this, the human health risk assessment (HHRA) for WS1 evaluates both an action alternative (treatment of water

by air stripping, the current situation) and a no-action alternative (a potential future scenario that could occur if air stripping were to be discontinued). The HHRA is summarized in Section 7.1.

An ecological risk assessment is a process that evaluates the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stressors. At WS1, the stressor consists of PCE in the groundwater, which occurs at a depth of about 200 feet below ground surface. As discussed further in Section 7.2, no exposure pathway to PCE in groundwater has been identified for ecological receptors.

7.1 HUMAN HEALTH RISK ASSESSMENT

An HHRA was performed to evaluate the risks to residents of Vancouver who use water produced from WS1 as their primary source of drinking water. The risk assessment consists of four main components:

- Identification of contaminants of potential concern (COPCs)
- Exposure assessment
- Toxicity assessment
- Risk characterization

These components are summarized in Sections 7.1.1 through 7.1.4. The qualitative uncertainty analysis is summarized in Section 7.1.5.

7.1.1 Identification of Contaminants of Potential Concern

In accordance with EPA Region 10 guidance, a risk-based screening approach was used to identify contaminants of potential concern (COPCs) in drinking water at WS1. The chemical screening consisted of comparing concentrations of chemicals detected in groundwater at WS1 to risk-based screening concentrations established by EPA. If the measured concentration of a chemical at WS1 exceeded the risk-based concentration, the chemical was identified as a COPC. Based on the screening procedure, the only COPC identified in untreated water produced from WS1 was PCE. No COPCs were identified in treated water.

7.1.2 Exposure Assessment

The exposure assessment identifies potential receptors and estimates the type and magnitude of exposures to the COPC (PCE) that was identified in Section 7.1.1. The results of the exposure

assessment are then combined with the chemical-specific toxicity information (see Section 7.1.3) to characterize potential risks (see Section 7.1.4).

The four steps in exposure assessment are characterization of the exposure setting and potential receptors, identification of exposure pathways, development of exposure point concentrations, and quantification of chemical intakes.

Characterization of Exposure Setting and Receptors

Four groups of receptors were evaluated:

- Public water supply users who are currently exposed to treated water
- Public water supply users who could be exposed to untreated water in the future if the air stripping treatment were to be discontinued or if private water supply wells were to be used for drinking water
- Site workers
- Nearby residents and recreational visitors

Identification of Exposure Pathways

The primary medium through which exposure may occur is water. Potential exposure pathways evaluated for WS1 are depicted in the human health conceptual site model shown in Figure 7-1. Potential exposure pathways include ingestion of water, dermal contact with water, and inhalation of PCE in air released during household use of water. Inhalation of PCE in fugitive air emissions from the water treatment system was also evaluated.

Exposure via Treated Water. Exposure pathways for current public water supply users are incomplete because no COPCs have been identified in treated water.

Exposure via Untreated Water. If water treatment were to be discontinued, or if private wells near WS1 were to be used as a drinking water source, water users could be exposed to PCE in drinking water. Potential exposure pathways for people using untreated water as a drinking water source include ingestion of untreated water, inhalation of PCE in untreated water during household use of water, and dermal contact with untreated water during bathing. Significant dermal exposures to untreated water by site workers are not expected to occur. Water is

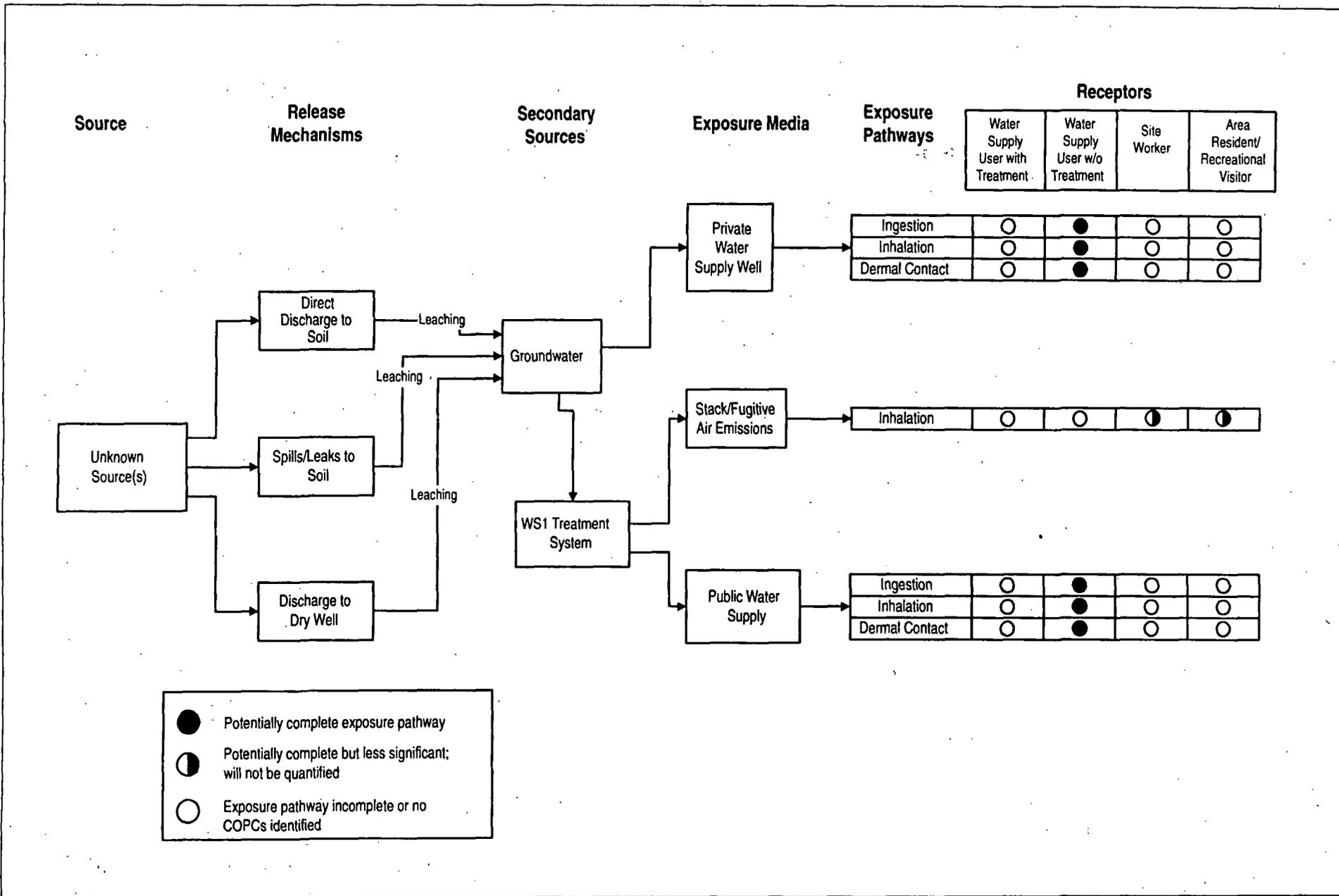


Figure 7-1
Human Health Conceptual Site Model

EPA Region 10
Vancouver Water Station 1
ROD

public water supply that would occur in the absence of treatment, because water from the individual wells would be blended in the reservoir prior to distribution, as was done prior to installation of the air strippers.

Quantification of Chemical Intakes

Chemical exposures, or intakes, were determined using exposure models that combine various exposure parameters related to behavior and physiology, such as exposure frequency and body weight, with exposure point concentrations. Reasonable maximum (or high end) exposures (RMEs) were evaluated for this HHRA.

The equations used to calculate intake from each exposure pathway are presented in the RI/FS and are consistent with guidance from EPA Region 10. Exposures were calculated for adults only. EPA default exposure parameters were used to quantify these models; sources for the exposure parameters include EPA Region 10 supplemental guidance and EPA standard default exposure factors. Exposure is averaged over a lifetime (70 years, or 25,550 days) for carcinogens and over the exposure duration for noncarcinogens. A body weight of 70 kg was assumed for all exposure pathways.

7.1.3 Toxicity Assessment

Carcinogenic Effects

PCE was found to produce liver cancer in male and female mice when administered orally by gavage. Unpublished gavage studies in rats and mice performed by the National Toxicology Program (NTP) showed hepatocellular carcinomas in mice and a slight, statistically insignificant increase in a rare type of kidney tumor.

In evaluating cancer, the numeric descriptor of carcinogenic potency is termed a slope factor (SF). The SF is defined as the UCL95 of the slope of the dose-response curve. The oral SF for PCE is $0.052 \text{ (mg/kg-day)}^{-1}$; the inhalation SF is $0.00203 \text{ (mg/kg-day)}^{-1}$. These slope factors are provisional toxicity values from EPA's National Center for Environmental Assessment (NCEA).

Noncarcinogenic Effects

Renal toxicity and hepatotoxicity were noted following chronic inhalation exposure of rats to PCE. During a subchronic inhalation study, exposure to PCE produced signs of central nervous system depression. Oral exposure of mice to PCE in corn oil resulted in depressed body weights and liver toxicity.

transported through the water station and treatment units via pipes, making direct contact with untreated water by workers unlikely.

Exposure via PCE in Air. Potential exposures of nearby residents and site workers may occur as a result of stack or fugitive emissions from the air strippers. According to the air permit issued by the Southwest Air Pollution Control Authority in 1993, the combined air emissions of PCE from the five air stripping columns will be controlled by five granular activated carbon canisters, and will not result in ambient air concentrations of PCE in excess of the applicable regulations. The emissions from the carbon canisters are released through a stack at a height of at least 12 feet above ground level. Therefore, although there will be some small release of PCE to the air, potential exposures to site workers, nearby residents, or recreational visitors to Waterworks Park are believed to be minimal.

Development of Exposure Point Concentrations

Exposure point concentrations are media-specific concentrations of a COPC that an individual may plausibly come into contact with. Exposure point concentrations were developed for the future residential scenario using PCE data collected between 1995 and 1997 from untreated water from individual production wells at WS1. It is conservatively assumed that the chemical concentrations remain constant over the assumed exposure period (i.e., 30 years).

EPA guidance states that "because groundwater is a very complex and dynamic medium with characteristics that can change seasonally, it is likely that concentrations of a given contaminant in each well will vary over time. Therefore, the concentration term is best described by an arithmetic average [over time]..." Because of the uncertainty associated with estimating the true arithmetic mean from a limited number of samples, a degree of conservatism is needed in calculating exposure point concentrations. This conservatism is provided by using the 95 percent upper confidence limit (UCL95) on the arithmetic mean, or the maximum detected value when the variability in the sampling results in a UCL95 that exceeds the maximum detected value.

For this HHRA, the sources of VOC contamination have not been identified and limited data do not allow a definition of a contaminated area within the capture zone of WS1. Therefore, the arithmetic average concentration (as represented by the UCL95) of PCE in each production well over time was used to characterize the range of potential future exposures to untreated water. Although PCE concentrations in the production wells appeared to be increasing in the late 1980s and early 1990s, concentrations have stabilized and have remained fairly constant or decreased slightly since the mid-1990s. Therefore, data collected during the last 3 years (i.e., 1995 through 1997) were considered appropriate for use in this HHRA. This range of potential exposures represented by the 10 production wells is believed to bound the actual exposures to users of the

For noncancer health effects, the toxicity values used in risk assessment are termed reference doses (RfDs). These are route- and duration-specific estimates of the average daily intake that can occur without appreciable risk of any adverse effect. The oral RfD for PCE is 0.01 mg/kg-day based on kidney toxicity. An uncertainty factor of 1,000 has been applied, and the overall confidence in the oral RfD is medium. The oral RfD was obtained from EPA's *Integrated Risk Information System* (IRIS) database. No inhalation RfD is available for PCE.

Dermal Toxicity Values

Calculation of risks from dermal exposures to groundwater requires dermal toxicity values. Dermal toxicity values must be based on the absorbed dose (rather than the exposed or administered dose), since dermal intakes are calculated as absorbed doses. Since EPA has not yet established any dermal toxicity values, approximate toxicity values were derived by extrapolation from oral toxicity values, assuming an oral absorption fraction of 1.

7.1.4 Risk Characterization

Risk characterization integrates the results of the exposure and toxicity assessments into a quantitative description of potential cancer and noncancer risks. The method for risk characterization used in the HHRA is consistent with EPA guidance.

The risk of cancer from exposure to a chemical is described in terms of the incremental probability that an individual will develop cancer over his or her lifetime as a result of exposure to a potential carcinogen. The resulting probabilities are expressed in numbers that indicate how many excess cancer cases are likely for a specified population. For instance, an excess cancer risk of 1E-06 corresponds to one additional cancer case in a population of 1,000,000 people. Similarly, an excess cancer risk of 1E-04 corresponds to one additional cancer case in a population of 10,000. Excess cancer risks are summed across all COPCs and all exposure pathways that contribute to exposure of an individual in a given population. Typically, remedial action is warranted when total excess cancer risks to any population exceed EPA's acceptable risk range of 1E-06 to 1E-04 (40 CFR Part 300.430).

Cancer risks were calculated for current and future residents using WS1 as the primary drinking water source. For current residents consuming treated water, no COPCs have been identified and therefore no excess cancers are expected to occur. For hypothetical future residents consuming untreated water (i.e., if treatment were to be discontinued), results are summarized in Table 7-1. Due to the inherent uncertainty in cancer risk calculations, total cancer risk values are reported to only one significant figure.

**Table 7-1
 Summary of Cancer Risks
 Associated With PCE in Untreated Water**

Production Well	Cancer Risk			
	Ingestion	Inhalation	Dermal Contact	Total
Well 1	3.6E-06	5.1E-07	2.2E-06	6E-06
Well 2	1.6E-06	2.2E-07	9.6E-07	3E-06
Well 3	2.1E-06	3.0E-07	1.3E-06	4E-06
Well 4	2.5E-06	3.6E-07	1.5E-06	4E-06
Well 5	2.4E-06	3.5E-07	1.5E-06	4E-06
Well 6	2.3E-06	3.3E-07	1.4E-06	4E-06
Well 7	1.5E-06	2.1E-07	9.2E-07	3E-06
Well 8	1.6E-06	2.2E-07	9.6E-07	3E-06
Well 9	8.1E-07	1.2E-07	5.0E-07	1E-06
Well 10	6.2E-07	8.9E-08	3.9E-07	1E-06

Based on UCL95 exposure point concentrations ranging from 1.0 to 5.7 $\mu\text{g/L}$ of PCE in the production wells, cancer risks to potential future public water supply users range from 1E-06 to 6E-06 (1 to 6 excess cancers in 1,000,000 people). The cancer risk is attributed primarily to water ingestion and dermal contact with water.

The potential for noncancer health effects from exposure to a chemical is evaluated by comparing the estimated intake of a chemical over a specific time period with the RfD for that chemical derived for a similar exposure period. This comparison results in a noncancer hazard quotient (HQ). Since exposure may occur simultaneously by more than one exposure pathway, HQ values are summed to obtain a hazard index (HI). If the total HI is equal to or less than 1, it is believed that there is no appreciable risk that adverse noncancer health effects will occur. If an HI exceeds 1, there is some possibility that adverse noncancer effects could occur, although an HI above 1 does not indicate an effect will definitely occur.

For current residents consuming treated water, no COPCs have been identified and therefore no noncancer health effects are expected to occur. For hypothetical future residents consuming untreated water (i.e., if water treatment were to be discontinued), noncancer HQ and HI values were calculated for each production well. Because of the uncertainty inherent in calculation of HQ values, all total HI values are reported to only one significant figure. Results are summarized

in Table 7-2. Based on UCL95 exposure point concentrations of 1.0 to 5.7 $\mu\text{g/L}$ of PCE in the production wells, the noncancer hazard to public water supply users ranges from an HI of 0.004 to 0.03. Since the total HI is less than 1, there is no appreciable risk that adverse noncancer health effects will occur.

Table 7-2
Summary of Noncancer Hazard
Associated With PCE in Untreated Water

Production Well ID	Hazard Quotient			Hazard Index
	Ingestion	Inhalation	Dermal Contact	
Well 1	0.015	NA	0.0097	0.03
Well 2	0.0068	NA	0.0043	0.01
Well 3	0.0092	NA	0.0058	0.02
Well 4	0.011	NA	0.0068	0.02
Well 5	0.011	NA	0.0066	0.02
Well 6	0.010	NA	0.0063	0.02
Well 7	0.0065	NA	0.0041	0.01
Well 8	0.0068	NA	0.0043	0.01
Well 9	0.0035	NA	0.0022	0.006
Well 10	0.0027	NA	0.0017	0.004

NA - not applicable because no inhalation reference dose was available for PCE

7.1.5 Uncertainty Assessment

There are a number of factors that can introduce uncertainty into any exposure and risk estimate. The key factors and assumptions that contribute to uncertainty in this risk assessment are summarized below.

Water samples collected from the production wells were pulled from the turbine pumps and therefore some VOCs may have volatilized during sample collection. EPA Superfund protocols recommend sampling for VOCs under low-flow conditions to minimize loss of VOCs during sampling. The effect of these sampling methods on concentrations of VOCs is not known; however, they may result in an underestimate of VOC concentrations and the corresponding human health risk.

Because reliable data on PCE concentrations in private wells were unavailable, untreated water samples collected from the production wells at WS1 were assumed to be representative of concentrations that would be found in hypothetical private water supply wells. However, because the source (or sources) of PCE in the groundwater have not been defined, there is considerable uncertainty associated with the potential PCE concentrations in off-site wells. Potential risks to area residents who use private wells as a drinking water supply could be higher than those presented in this HHRA.

The risk-based screening concentration (RBSC) comparison was designed to be conservative and the elimination of chemicals is not likely to result in a significant underestimate of risk. The most recent analytical results for a wide variety of analytes in untreated water are the contaminant testing results for 1992, the year prior to installation of the air stripping towers. These data may not reflect the current concentrations of organic and inorganic contaminants (other than PCE) in untreated groundwater. To the extent that the 1992 data do not reflect current conditions (i.e., if concentrations of contaminants other than PCE have increased), the COPC selection process may have resulted in the elimination of chemicals that may currently be present at levels above the RBSCs.

In some cases, analytical procedures were not sensitive enough to detect chemicals potentially present at levels above RBSCs. For 1,1-dichloroethene and vinyl chloride, high sample quantitation limits and their potential presence in the aquifer associated with WS1 may result in an underestimate of risk.

The evaluation of human health risks used arithmetic average concentrations over a period of time from 1995 through 1997. It is not known whether concentrations will decline over the long term as natural attenuation processes degrade the COPCs, which would decrease risk, or whether input from existing or potential future sources may result in an increase in concentrations of VOCs, which would increase risk. Therefore, potential future risks may be over- or underestimated. The magnitude of this potential over- or underestimate cannot be determined with available information.

The daily intakes in this risk assessment were calculated using conservative exposure assumptions (e.g., intake rate, exposure frequency, exposure duration). This may result in an overestimate of risk.

Risks from dermal exposures were calculated based on dermal toxicity values extrapolated from oral values using an absorption fraction of 1. Although organics are generally readily absorbed, this assumption is associated with a small degree of uncertainty. Thus, actual risks may be slightly underestimated.

No EPA-approved cancer SFs exist for PCE. The oral and inhalation SFs used in this HHRA are based on provisional values presented in NCEA memoranda, as presented in EPA Region 3 risk-based concentration tables. Therefore, there is a high degree of uncertainty associated with the cancer toxicity of this compound, and the actual risks may be over- or underestimated.

Quantification of risk from exposure to a chemical cannot be accomplished in the absence of reliable, appropriate toxicity values for all routes and exposure periods. PCE does not have an inhalation RfD value. Thus no noncancer health effects were calculated for inhalation of PCE. Noncancer health effects from inhalation of PCE are likely to be underestimated. In summary, estimates of exposure and risk are subject to a number of uncertainties that may lead to either an overestimate or an underestimate of risk. In either case, however, the selected remedy will not change.

7.2 ECOLOGICAL RISK EVALUATION

An ecological risk assessment is a process that evaluates the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stressors. The EPA framework consists of a three-step approach:

- Problem formulation
- Analysis
- Risk characterization

Problem formulation is a formal process for generating and evaluating preliminary hypotheses about why and how ecological effects may occur as a result of human activities. During problem formulation, available information is collected about the sources of stressors, the characteristics of the stressors, exposure to the stressors, the ecosystem potentially at risk, and ecological effects. Assessment endpoints can then be identified, and a conceptual site model developed. During the analysis phase, measures of exposure, effects, and ecosystem and receptor attributes are used to evaluate questions and issues identified during problem formulation. During the risk characterization phase, the results of the analysis phase are used to estimate risks to the assessment endpoints.

The ecological evaluation performed for WS1 is qualitative in nature and does not extend beyond the problem formulation phase. The stressor present at the site is PCE in the groundwater. Groundwater occurs at a depth of about 200 feet below ground surface at the site. Most of WS1 is located in a municipal park, and potential ecological receptors, including birds, small mammals,

and invertebrates, may be present. However, no exposure pathways to contaminants in groundwater have been identified for these receptors.

The aquifer that supplies raw water to WS1 (Orchards Gravel) is believed to discharge to the Columbia River. Although the Columbia River sustains major fisheries, it transports vast quantities of water; infiltration of groundwater from the Orchards Gravel would be unlikely to result in a detectable impact on water quality.

Therefore, because no potentially complete and/or significant exposure pathways exist at WS1, the potential ecological risk is considered minimal.

8.0 REMEDIAL ACTION OBJECTIVES

8.1 NEED FOR REMEDIAL ACTION

Even though the risks presented in the baseline risk assessment are within the NCP acceptable risk range, it is necessary to take an action at WS1 because groundwater has been shown to have persistent concentrations of PCE above the MCL. EPA's 1991 guidance (*Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions*) states that exceedances of the MCL can trigger the need for action. In addition, the NCP requires that MCLs must be met in groundwater, not just at the tap.

There are many uncertainties associated with this risk assessment. Even so, the fact that groundwater at WS1 exceeds MCLs from time to time is sufficient to require remedial action.

Actual or threatened releases of hazardous substances from WS1, if not addressed by implementing the response action selected in this ROD, may present imminent and substantial danger to public health.

8.2 NO IDENTIFIED SOURCE

Although several investigations have been conducted, neither a source nor a plume of PCE entering the wellfield has ever been identified. Soil-gas surveys conducted to the north of the wellfield (in the immediate vicinity of MW1-1) detected the presence of PCE, TCE, TCA, and toluene. The concentrations of PCE detected in the area, however, were not high enough to indicate a source of PCE that could be responsible for the contamination at the wellfield.

Monitoring wells at and immediately adjacent to the wellfield have not shown concentrations of PCE above the MCL.

8.2.1 Potential Sources of Contamination

Investigations have failed to identify a suspected source that could be responsible for the PCE contamination measured in the wellfield. Historically, however, there were a number of dry cleaners, auto repair shops, and other commercial operations that may have used PCE in the area near WS1, particularly during and following World War II. With a 30-year zone of capture estimated at approximately 10 square miles, and a 50-year zone of capture even larger in size, there are a large number of possible sources of a release of PCE. Because PCE is so persistent in the subsurface environment and can travel large distances, a release (or releases) from 50 years ago could be responsible for the contamination measured today. WS1 has been operating for decades, and all groundwater within the wellfield's zone of capture will eventually be pulled into the production wells.

Practices of solvent management in the past were considerably more casual than those of today. Strict environmental laws and regulations have greatly reduced the release of chemicals such as PCE to the environment. The results of past practices, however, can result in significant environmental problems. The contamination at WS1 is very likely the result of past practices; there is no evidence of a recent or continuing release.

Two scenarios could account for the PCE at WS1: (1) a single, relatively large release, perhaps several decades ago, and (2) a number of smaller, separate releases from separate sources such as dry cleaners. There is no known evidence of a single, large release in the vicinity of WS1, so the second scenario is the most probable explanation for PCE contamination at WS1. A contributing factor may also be the fact that runoff captured in stormdrains is disposed of through dry wells throughout the city of Vancouver, including the area around WS1. Any solvent allowed to drain to a parking lot, street, or other paved area could eventually work its way into the groundwater. Over decades, particularly with a large number of dry cleaners in the vicinity, this could lead to the PCE contamination present in the groundwater at WS1.

Whatever the source and history of the release of PCE that is now contaminating WS1, it is certain that the PCE was released at the surface and was transported to the groundwater as a liquid or as a vapor. Calculations performed during the RI/FS process showed that it was extremely unlikely that measured PCE as a vapor in the soil column would produce the concentrations detected in groundwater at WS1. So it is reasonable to conclude that the PCE in the groundwater was transported as either an aqueous solution (with a maximum concentration of

1,100 mg/L), or as a dense, nonaqueous phase liquid (DNAPL), either as pure PCE or in a solution of other oils and solvents.

8.2.2 Transport of PCE to Water Station 1

The majority of data available for this site are the water samples collected every week (or month) from each of the 10 production wells. These samples are analyzed for PCE only. Since monitoring began in June 1991, there have been approximately 80 weekly or monthly sampling events, with a sample collected from most wells during each event. Approximately 1,500 production well samples from WS1 have been analyzed for PCE since June 1991.

PCE has been detected in all 10 of the production wells at WS1. Within the wellfield, the area with the highest concentration of PCE varies over time, although the well with the highest concentration of PCE for any given sampling event is typically either at the north end of the site or the south end. The maximum PCE concentration among the production wells for each weekly or monthly sampling event has been routinely greater than the MCL. Approximately 50 percent of these maximum PCE concentrations for a given week or month have occurred in Production Well 1 at the north edge of the wellfield. The second highest percentage of period maximums is in Production Well 5 (with slightly less than 20 percent) located at the southeast corner of the wellfield. The remaining eight wells have each had the maximum weekly or monthly concentration roughly 5 percent of the time or less.

Although PCE has been routinely measured in the wellfield, it has been detected in only one of the four monitoring wells that roughly flank the wellfield—MW1-3, which is located in the southeast corner near Production Wells 4, 5, and 6. (Monitoring well data are, however, quite limited; none of the wells has been sampled more than three times.) The other three monitoring wells, located to the north, west, and east of the site, have never had a detected concentration of PCE. The concentrations of PCE in samples collected from MW1-3, all of which were below the MCL, seem to correlate reasonably well with the concentrations in the three nearby production wells.

A fifth monitoring well, MW1-5, located approximately one-third mile to the south (downgradient) of the wellfield, has had PCE detected in each of the three samples collected from the well; only one sample, collected in 1992, exceeded the MCL. MW1-5 may be near the edge of the capture zone for WS1.

The data from the production wells could indicate that PCE is entering the wellfield from separate locations, one from the north and one from the south. There is, however, no indication of a definable plume (or plumes) of PCE entering the wellfield. At the north end of the wellfield, for example, monitoring well MW1-1 (located across the street from the wellfield and within about

200 feet of Production Well 1) has never had a detectable concentration of PCE. Production Well 7, located approximately 100 feet to the southeast of Production Well 1, has typically had lower concentrations than Production Well 1, although the most recent sampling data show a higher concentration in Production Well 7. At the southern end of the wellfield, Production Wells 4 and 6, located close to Production Well 5, have had consistently and significantly lower concentrations of PCE than Production Well 5, while monitoring well MW1-3, located in the same general area, has never had a detection of PCE above the MCL.

The variation in maximum levels within the wellfield, together with the fact that none of the monitoring wells in the vicinity of WS1 has ever had a detected concentration of PCE above the MCL, indicate that there is not a definable plume of PCE entering the wellfield. The most plausible explanation of PCE transport to the wellfield is that PCE is being pulled into the production wells through one or more narrow "channels" of contamination originating outside the wellfield. This explanation is consistent with experience at other sites with groundwater contaminated by PCE and similar chemicals. Given a high probability that the PCE is entering the wellfield through these narrow channels, it is possible that a much more extensive array of monitoring wells would fail to identify a pathway of PCE into the wellfield.

8.2.3 Representativeness of Production Well PCE Concentrations

During the remedial investigation, the issue arose concerning the representativeness of PCE concentrations from samples pulled directly from the production wells. Typically, environmental samples for VOCs are taken using low-flow techniques to minimize the volatilization of chemicals being analyzed for. It is possible that the high flow rate in a production well reduces the concentration of PCE in a sample taken from the well; that is, a sample taken from the same well at the same time using a low-flow technique would show a higher concentration of PCE. Because low-flow samples cannot be taken from any of the production wells, it is not possible to directly compare the results of high-flow and low-flow sampling from the same well. The comparison of samples taken at MW1-3 with samples collected at approximately the same time from nearby production wells could be a reasonable indication that PCE concentrations reported in production well samples are not significantly under-reported.

8.2.4 Conclusion

In conclusion, the PCE contamination at WS1 is persistent and present at levels that require continuing treatment to protect human health. (There are no complete pathways for ecological receptors.) There is no suspected PCE source, and further investigation to identify sources would be unlikely to affect the current status of continuing operation of the air stripping system. Additional investigation into possible sources or channels into the wellfield would be very

expensive but would not necessarily identify either a source or a channel. Even if a source or a channel were identified, it is likely that no additional action would be taken, given that groundwater is 200 feet below ground surface. It is therefore appropriate to continue treating the water from WS1, both to remove PCE from the drinking water supply and to reduce the concentration of PCE in the groundwater. But further action to find either a source or a channel of PCE entering the wellfield would not be cost-effective and would not further reduce risk.

8.3 REMEDIAL ACTION OBJECTIVES

Actual or threatened releases from the site, if not addressed by implementing the selected response action, may present an imminent and substantial endangerment to human health and the environment.

The primary remedial action objective for WS1 is to

- Protect human health by reducing concentrations of PCE and other VOCs in drinking water produced from WS1 to below the MCL specified in regulations promulgated under the federal Safe Drinking Water Act (SDWA) and in the state drinking water regulations

An additional remedial action objective for WS1 is to

- Protect human health by reducing concentrations of PCE and other VOCs in groundwater at WS1 to below the Method A cleanup level specified in the Washington State Model Toxics Control Act (MTCA) regulations and below the federal and state drinking water standards (MCLs)

The federal MCL and the state cleanup levels are both 5.0 $\mu\text{g/L}$.

9.0 DESCRIPTION OF ALTERNATIVES

At WS1 a treatment system consistent with EPA's presumptive remedy for VOCs in groundwater (OSWER Directive 9283.1-12, October 1996) has been constructed and is operating effectively. Locating and removing the source of contamination is not feasible. Accordingly, the feasibility study was limited to evaluation of the operating treatment system alternative and the no-action

alternative. Evaluation of a no-action alternative is required under CERCLA to establish a baseline for comparison.

As discussed in Section 8, the two remedial action objectives for WS1 are to treat the water to achieve the MCL for PCE and other volatile compounds both at the tap and in groundwater.

9.1 THE OPERATING TREATMENT SYSTEM ALTERNATIVE

The operating treatment is air stripping. Air stripping is a treatment technology in which the water to be treated trickles down through a tower in a "packed column" that breaks up the flow of water to create as much surface area as possible, as illustrated in the drawing of a typical packed tower configuration (Figure 9-1). Large volumes of air are then forced upward through the water, transferring the volatile contaminants from the surface of the water to the air through the process of evaporation. The air to which the contaminants have been transferred is in turn treated by being forced through carbon filters, which adsorb the contaminants. The filters are then regenerated or treated and disposed of as a hazardous waste. This alternative includes monitoring both the untreated and the treated water to ensure cleanup standards are met.

The air stripping system at WS1 consists of five packed towers, and has been operating since 1993. Use of air stripping has reduced concentrations of PCE (and other VOCs that may be present) in treated water to below the level of detection.

9.2 THE NO-ACTION ALTERNATIVE

Under the no-action alternative, there would be no treatment of water to remove PCE. Although blending the output from all wells could reduce the PCE concentration to below the MCL, it is likely that areas of the aquifer under WS1 would contain groundwater with PCE at concentrations greater than the MCL. On-going monitoring of the water would continue under the no-action alternative.

It should be noted, however, that the City of Vancouver has no plans to discontinue treatment and would only do so if further investigations were conducted that demonstrate that no other VOCs are present in the groundwater and that PCE concentrations in groundwater have fallen to below the MCL.

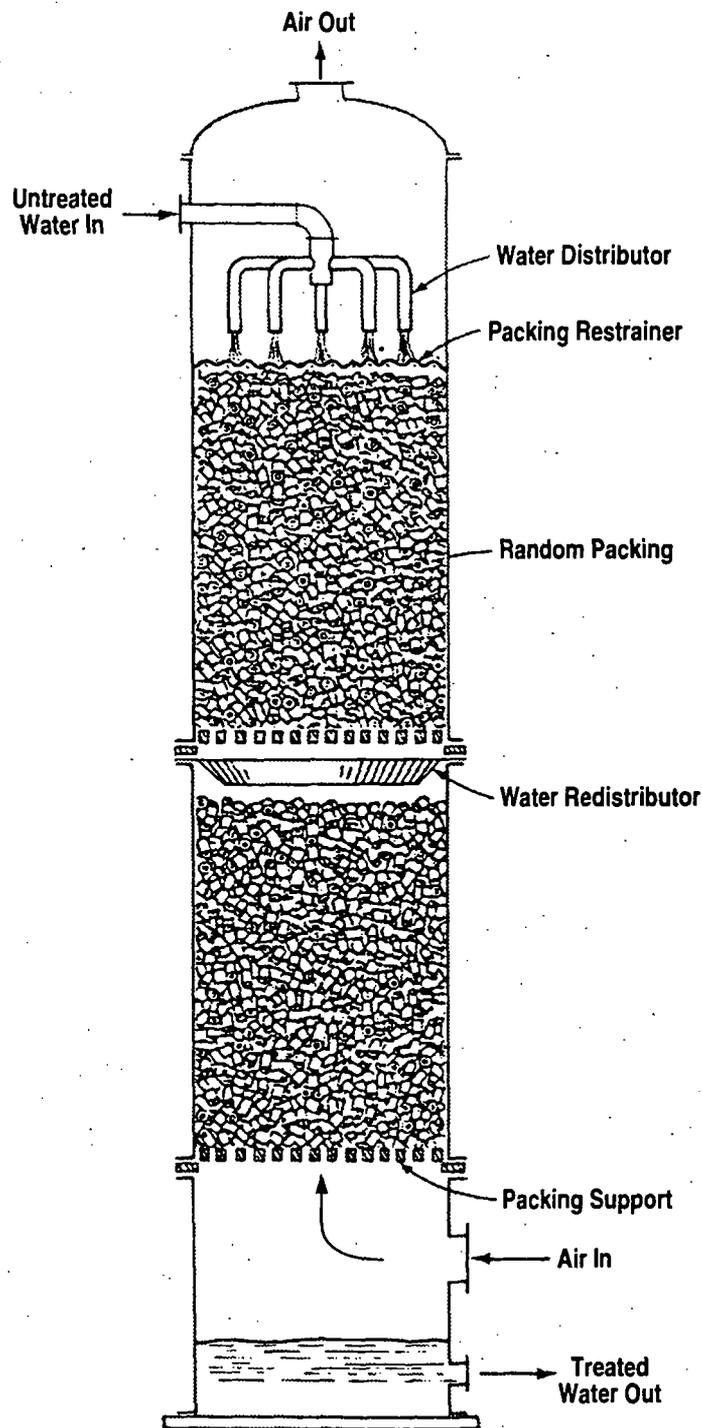


Figure 9-1
Typical Air Stripper

EPA Region 10
Vancouver Water Station 1
ROD

10.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

EPA has established nine criteria for the evaluation of remedial alternatives:

1. Overall protection of human health and the environment
2. Compliance with ARARs
3. Long-term effectiveness and permanence
4. Reduction of toxicity, mobility, and volume through treatment
5. Short-term effectiveness
6. Implementability
7. Cost of implementation
8. State acceptance
9. Community acceptance

The following sections summarize the detailed evaluation of alternatives in regard to these nine criteria. For the WS1 site, the evaluation of alternatives is limited to the operating treatment system alternative and the no-action alternative.

10.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The operating treatment, air stripping, has been proven to be effective in removing VOCs from water, based on operational data at this and other sites. It therefore meets the threshold criterion of protecting human health. (There is minimal risk to the environment from this site because there is no potentially complete and/or significant exposure pathway to untreated water for ecological receptors.) If compared against other removal technologies or measures, air stripping would be rated excellent for protecting human health.

The no-action alternative might not be protective of current human health because routine monitoring of untreated water has shown occasional concentrations of PCE above the MCL. Furthermore, because the samples taken from untreated water were analyzed only for PCE, it is possible that other VOCs are present in the groundwater, which would increase risk. Given this uncertainty, the no-action alternative may not be adequately protective of human health. The no-action alternative will not be protective in the future because there would be no effort to remove the contaminated groundwater; private wells may therefore be more exposed to risk.

10.2 COMPLIANCE WITH ARARS

This criterion states that remedial alternatives will meet all applicable or relevant and appropriate requirements (ARARs) of other federal and state environmental and public health laws or provide justification for invoking a waiver. There are three types of ARARs: chemical-specific, location-specific, and action-specific.

The chemical-specific ARARs for this site are the following:

- Federal and state Safe Drinking Water Act MCL of 5.0 $\mu\text{g/L}$
- Washington State Model Toxics Control Act (MTCA) Method A level for PCE of 5.0 $\mu\text{g/L}$

The operating air stripping system as installed is compliant with chemical-specific, location-specific, and action-specific ARARs. Moreover, if evaluated against other technologies or remedial measures, air stripping would be rated excellent for compliance with state and federal ARARs.

Treatment or disposal of spent carbon from the strippers, if the spent carbon is determined to be dangerous waste, must be compliant with Resource Conservation and Recovery Act (RCRA) Subtitle C and Washington State dangerous waste regulations.

The no-action alternative might not be compliant with ARARs because concentrations in samples of untreated water have occasionally exceeded the MCL. Under both the NCP and MTCA, the concentrations noted above must be met both at the tap and throughout the groundwater.

10.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

Remedial alternatives are typically assessed for long-term effectiveness and permanence and the degree of certainty that the alternative will prove successful in overall protection of human health and the environment.

The operating treatment system, with continued operation and maintenance, is effective in removing PCE (and other VOCs that may be present) from water. This treatment is permanent and achieves a high degree of certainty of success.

The no-action alternative would rate relatively low for long-term effectiveness and permanence because there would be no removal of contaminants from water.

10.4 REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT

This criterion assesses the degree to which the alternatives use active treatment to reduce toxicity, mobility, and volume of the principal threats posed to the site and local environment. The operating treatment system is very effective at removing VOCs from water, and therefore reduces the toxicity and volume through treatment. The treatment is irreversible and leaves no detectable concentrations of VOCs.

The no-action alternative would rely on natural degradation processes to reduce the toxicity, mobility, and volume of PCE. These degradation processes are complicated, and have not been examined in sufficient detail at this site. As such, the no-action alternative would rate very low for this criterion.

10.5 SHORT-TERM EFFECTIVENESS

The alternatives were evaluated in terms of their effectiveness in protecting human health and the environment during construction and implementation of the remedy and until the response objectives have been met.

The operating treatment system has already been installed, so there are no short-term effectiveness considerations for this site. Had the system been evaluated under this criterion before a decision was made, however, air stripping would have rated highly effective because the technology is well established and has proven to have relatively few short-term risks or potential environmental impacts. The proven nature of the technology also means that a construction schedule would have relatively few uncertainties.

The no-action alternative would probably rate average for short-term effectiveness. Although there are no impacts or risks for implementation of the no-action alternative, the time until protection is achieved would be very long.

10.6 IMPLEMENTABILITY

The technical and administrative feasibility of the alternatives was evaluated.

The operating treatment system has a well-established history as an effective means of treating water contaminated with VOCs. Air stripping systems are relatively simple to design and straightforward to maintain. Start-up and shut-down can be accomplished quickly, and the modular design makes air stripping easy to construct. Air stripping would rate high for implementability in any comparison with other alternatives for water treatment.

The no-action alternative would be easily implementable, so it would also rate high for this criterion.

10.7 COST OF IMPLEMENTATION

According to the City of Vancouver, the air stripping system at WS1 cost approximately \$4 million to design and build. Operating costs are estimated to be approximately \$60,000 per year, not including depreciation. Air stripping systems typically rate well in comparison to other, equally effective treatment alternatives such as activated carbon or ultraviolet treatment of the water. Because how long the system will be needed is unknown, operating costs (and possibly replacement costs for a new system) could lead to a lower rating of air stripping for this criterion.

The no-action alternative would rate high for cost of implementation because there is no cost for the no-action alternative.

10.8 STATE ACCEPTANCE

This criterion was evaluated following the receipt of state agency and public comments on the RI/FS report and the Proposed Plan.

The Washington State Department of Ecology has reviewed the operating system alternative and has accepted the remedy.

10.9 COMMUNITY ACCEPTANCE

The community was given the opportunity to review the Proposed Plan and to request a public meeting if so desired. Two written comments were received. There was no request for a public meeting and there were no objections to EPA's Proposed Plan.

11.0 THE SELECTED REMEDY

The selected remedy for cleanup of both groundwater and drinking water produced from WS1 is air stripping. This remedial approach is consistent with EPA's presumptive remedy for contaminated groundwater. It is protective of human health and the environment and provides the best overall effectiveness proportional to its costs; the remedial approach includes treatment as a principle element. The selected remedy also includes monitoring to evaluate system effectiveness at removing PCE from both groundwater and drinking water produced from WS1.

11.1 AIR STRIPPING

Air stripping is a treatment technology in which the water to be treated trickles down through a tower in a "packed column" that breaks up the flow of water to create as much surface area as possible (Figure 9-1). Large volumes of air are then forced upward through the water, transferring the volatile contaminants from the surface of the water to the air through the process of evaporation.

The air to which the contaminants have been transferred is then treated by forcing it through carbon filters, which adsorb the contaminants. The filters are then regenerated or treated and disposed of as a hazardous waste.

The air stripping system at WS1 consists of five packed column towers, and has been operating since 1993. Use of air stripping has reduced concentrations of PCE in production water to below the level of detection.

The air stripping system is, and will continue to be, operated by the City of Vancouver. All drinking water produced by WS1 will be treated by the air stripping system until the City, the Washington State Department of Ecology, and EPA agree that the remedial action objectives have been met and the treatment can be terminated.

Groundwater will be pumped from WS1 at a rate that varies between 8 and 19 million gallons per day, depending on the time of year and customer demand. All water pumped by WS1 will be treated and distributed to customers as drinking water. Estimated costs for this remedy are:

Capital costs: \$4,000,000
Operating and Maintenance costs: \$60,000 per year (includes monitoring but not depreciation)

11.2 GROUNDWATER CLEANUP

By extracting and treating large volumes of groundwater for drinking water, WS1 acts as a very large pump-and-treat system for removing contaminants from the aquifer near WS1. The capture zone for WS1 is estimated to be approximately 10 square miles over a 30-year period of time; any contamination within this zone will eventually be pulled into the wellfield at WS1. Although the large capture zone has made it impractical to try to identify a source of the PCE, the high pumping rates for the production wells provide an effective means of reducing the concentration of PCE in the groundwater near WS1. Eventually, the extraction of groundwater will flush out residual contaminants in the wellfield, although the time to achieve the remedial action objectives is not known.

11.3 GROUNDWATER MONITORING

Periodic monitoring of the groundwater will be performed by both the City of Vancouver and EPA to evaluate the effectiveness of and the need for continued operation of the treatment system at WS1. Groundwater monitoring will consist of sampling production wells and monitoring wells for PCE and other volatile organic compounds. The City of Vancouver will continue to monitor the water at WS1 and will take at least one sample each year from each operating production well. EPA will continue to review the City's data and will periodically, but no less often than every 5 years, sample the available monitoring wells near WS1.

The results of groundwater monitoring will be evaluated annually and at the 5-year review for WS1. Decisions on whether to continue and/or modify the monitoring program will be made by EPA in conjunction with the City of Vancouver and the Washington Department of Ecology.

12.0 STATUTORY DETERMINATIONS

Under CERCLA Section 121, EPA must select remedies that are protective of human health and the environment, comply with applicable or relevant and appropriate requirements (unless a statutory waiver is justified), are cost-effective, and use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as their principal element. The following sections discuss how the selected remedy meets these statutory requirements.

12.1 PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The selected remedy protects human health through treatment of drinking water produced from WS1 as well as groundwater by using air stripping to reduce PCE concentrations. The contamination of groundwater at WS1 with PCE does not pose a threat to the environment because the groundwater is 200 feet below ground surface.

Treatment of water produced from WS1 by air stripping reduces PCE concentrations to below detectable levels and therefore there were no chemicals of potential concern identified in treated water. There are no excess cancer or noncancer risks associated with ingestion, inhalation, or dermal contact with chemicals of concern in treated water because no such chemicals were identified.

Air emissions for the treatment system are in compliance with the permit issued by the Southwest Air Pollution Control Authority.

12.2 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) AND OTHER CRITERIA AND GUIDANCE

12.2.1 ARARs

The selected remedy, treatment of drinking water produced from WS1 by air stripping, will comply with all applicable or relevant and appropriate requirements (ARARs) that have been identified. The ARARs are presented below.

- **National Primary Drinking Water Regulations (40 CFR Parts 141.50 and 141.60) and Washington State Maximum Contaminant Levels (MCLs) (WAC Chapter 246-290-330).** These regulations are applicable to water at the tap. The federal MCL is relevant and appropriate to the groundwater of this drinking water aquifer.
- **Washington State Model Toxics Control Act Cleanup Regulations (WAC Chapter 173-340-720).** The groundwater cleanup levels established in the MTCA cleanup regulations are applicable to the groundwater at this site.
- **RCRA Regulations (40 CFR Part 261) and Washington Dangerous Waste Regulations (WAC Chapter 173-303).** The City of Vancouver has designated the spent activated carbon units from the air strippers as dangerous waste. The units are sent off site for regeneration or disposal as dangerous waste, and as such the requirements for manifesting and transport as a dangerous waste and treatment or disposal at a permitted treatment, storage, or disposal RCRA Subtitle C facility are applicable.
- **U.S. Department of Transportation (49 CFR Parts 171 through 180) and Washington State Transportation of Hazardous Waste Materials (WAC Chapter 446-50).** If the spent activated carbon units contain hazardous waste, these transportation requirements would be applicable.
- **Washington Minimum Functional Standards for Solid Waste Handling (WAC Chapter 173-304); Washington Criteria for Municipal Solid Waste Landfill (WAC Chapter 173-351); County Health District regulations.** If carbon filters are NOT dangerous waste then they will be disposed of off site as solid waste under the applicable regulations.
- **General Regulations for Air Pollution Sources (Section 400), Southwest Air Pollution Control Authority.** The City of Vancouver submitted Notice of Construction CL-948 to SWAPCA for installation of carbon filters to capture volatile emissions from the air strippers. On October 21, 1993, the City was granted Order of Approval SWAPCA 93-1499 to operate the air pollution control equipment. Therefore, the requirements of the General Regulations and the Order of Approval are applicable to the operation of the air strippers. Independent of CERCLA, the requirements of this permit (Order of Approval) are the air pollution control ARAR requirements.

12.2.2 Other Criteria, Advisories, or Guidance To Be Considered (TBCs) for This Remedial Action

If the spent activated carbon used in treating the air stream at the air stripping system is disposed or treated off site, the National Contingency Plan off-site disposal rule (58 FR 49200, September 22, 1993) must be followed.

12.3 COST-EFFECTIVENESS

EPA believes this remedy eliminates the risks to human health. The system was designed and installed in 1993 at an estimated cost of \$4 million and has been operating successfully since then at an estimated cost of approximately \$60,000 a year for operation and maintenance and monitoring but not including depreciation. Therefore the selected remedy provides an overall effectiveness proportionate to its costs, such that it represents a reasonable value for the money.

The selected remedy ensures a high degree of certainty that the remedy will be effective in the long term because of the significant reduction of the contamination in the water that has been achieved to date through use of the existing air stripping system. No other treatment options were evaluated because the existing system was already in operation when the site was listed on the NPL and the technology has proven to be effective for removal of VOCs from water. However, the cost for installing and operating an air stripping system compares well to other, equally effective treatment alternatives such as activated carbon or ultraviolet treatment.

12.4 USE OF PERMANENT SOLUTIONS AND ALTERNATIVE TREATMENT TECHNOLOGIES (OR RESOURCE RECOVERY TECHNOLOGIES) TO THE MAXIMUM EXTENT PRACTICABLE

The selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be used in a cost-effective manner for final source control at WS1. No source for the PCE in groundwater at WS1 has been identified within WS1, and numerous investigations have failed to determine an off-site source or sources of the PCE in the groundwater at WS1. Therefore a remedy that is limited to treatment of the drinking water produced from WS1 has been determined to represent the maximum extent to which permanent solutions and treatment technologies can be used in a cost-effective manner.

Because air stripping was already in operation when WS1 was listed on the NPL, it was the only remedy evaluated. However, treatment of the water using air stripping has been proven to be

protective of human health, and it complies with ARARs. EPA and the State of Washington have determined that air stripping provides the best balance of trade-offs in terms of long-term effectiveness and permanence; reduction in toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost; while also considering the statutory preference for treatment as a principal element and considering state and community acceptance.

Air stripping, the selected remedy, treats the principal threat posed by exposure to drinking water produced from WS1 by reducing the concentration of PCE in treated water to below detectable levels. This remedy provides a proven technology for removal of PCE from water and is cost-effective. The selection of air stripping treatment of the contaminated water is consistent with program expectations that indicate that contamination in water used for public drinking water supply is a priority for treatment. The selection of air stripping treatment as EPA's remedy ensures long-term effectiveness by requiring that the treatment system remain in operation as long as necessary to reduce PCE concentrations in groundwater around WS1 to less than 5.0 $\mu\text{g/L}$.

12.5 PREFERENCE FOR TREATMENT AS A PRINCIPAL ELEMENT

Treatment by air stripping addresses the principal threat posed by drinking water produced from WS1 through the use of a proven treatment technology. By using treatment as the sole remedy, the statutory preference for remedies that employ treatment as a principal element is satisfied.

13.0 DOCUMENTATION OF SIGNIFICANT CHANGES

The Proposed Plan, released for public comment in July 1998, discussed remedial action alternatives for WS1 and identified air stripping as EPA's preferred alternative. No public meeting was scheduled because no new alternatives were presented in the Proposed Plan. The public comment period was July 22, 1998, to August 21, 1998. Two written public comments were received.

EPA reviewed the written comments submitted during the comment period. Upon review of the comments, it was determined that no significant changes to the remedy for WS1, as it was originally identified in the Proposed Plan, were necessary to satisfy public concerns.

APPENDIX A

Responsiveness Summary

APPENDIX A Responsiveness Summary

This responsiveness summary addresses public comments on the Proposed Plan for remedial action at Water Station 1 (WS1) at Vancouver, Washington.

The RI/FS report and Proposed Plan were released for public comment in July 1998. The two documents were made available to the public in the Administrative Record maintained at U.S. EPA Region 10, 1200 Sixth Avenue, Seattle, Washington, and at the information repository maintained at the Vancouver Public Library, Fort Vancouver Branch, 1007 E. Mill Plain Boulevard, Vancouver, Washington. The notice of availability of these two documents was published in the *Vancouver Columbian* on July 22, 1998.

The public comment period was held from July 22, 1998, to August 21, 1998. Two written comments were received.

No public meeting was scheduled. The public had an opportunity to request a public meeting. No requests for a public meeting were received.

Comment 1: *The commenter felt that the City of Vancouver should not limit its investigation of potential sources of tetrachloroethene (PCE) to past uses by dry cleaners but should investigate current use by plastics companies in the vicinity. Several potential sources were named.*

Response: The comment was more appropriate to Water Station 4, and EPA will be following up on the information provided by the commenter regarding potential sources.

Comment 2: *The commenter was concerned with the quality of Vancouver's drinking water and felt that even 1 excess cancer per 1,000,000 people exposed was an unacceptable level of risk.*

Response: EPA shares the commenter's concern with water quality. Excess cancer risks for a chemical in water, in this case PCE, can only be calculated based on a detectable amount of the chemical in water. The 1 in 1,000,000 risk that the commenter mentions was the low end of the range of risks calculated for exposure to PCE in untreated water. EPA's selected remedy for treatment of the PCE in drinking water at WS1 is air stripping, which removes PCE from water so effectively that PCE cannot be detected in the treated water from WS1, even when using the most sensitive laboratory tests. There is no risk from drinking treated water that can be quantified, and thus EPA believes the selected remedy is protective of human health.